

UTILITY
PATENT APPLICATION
TRANSMITTAL

Attorney Docket No.

EN997170C

First Named Inventor or Application Identifier

Michael A. Gaynes et al.

Title

BONDING TOGETHER SURFACES

Express Mail Label No.

APPLICATION ELEMENTS

ADDRESS TO:

Assistant Commissioner for Patents
Box Applications
Washington, D.C. 20231

1. ☒ Filing fee as calculated below.

2. ☒ Specification [Total Pages **[15]**]

(preferred arrangement set forth below)

- Descriptive title of the invention
- Cross References to Related Applications
- Statement Regarding Fed sponsored R & D
- Reference to Microfiche Appendix
- Background of the Invention
- Brief Summary of the invention
- Brief Description of the Drawings (if filed)
- Detailed Description
- Claim(s)
- Abstract of the Disclosure

3. ☒ Drawing(s) (35 USC 113) [Total Pages **[1]**]

4. ☒ Oath or Declaration [Total Pages **[2]**]

a. ☐ Newly executed (original or copy)

b. ☒ Copy from a prior application (37 CFR 1.63(d))
(for continuation/divisional with Box 17 completed)

☐ DELETION OF INVENTOR(S)

Signed statement attached deleting inventor(s)
named in the prior application, see 37 CFR 1.63(d)(2)
and 1.33(b)

5. ☒ Incorporation By Reference (useable if Box 4b is
checked) The entire disclosure of the prior application, from which
a copy of the oath or declaration is supplied under Box 4b, is
considered as being part of the disclosure of the accompanying
application and is hereby incorporated by reference therein.

6. ☐ Microfiche Computer Program (Appendix)

7. ☐ Nucleotide and/or Amino Acid Sequence
Submission (if applicable, all necessary)

- a. ☐ Computer readable copy
- b. ☐ Paper Copy (identical to computer copy)
- c. ☐ Statement Verifying identity of above
copies

8. ☐ Assignment papers (cover sheet & document(s))

9. ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney

10. ☐ English Translation Document (if applicable)

11. ☐ Information Disclosure ☐ Copies of IDS
Statement (IDS)/PTO-1449 Citations

12. ☒ Preliminary Amendment

13. ☒ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)

14. ☐ Small Entity ☐ Statement filed in prior application,
Statement(s) Status still proper and desired

15. ☐ Certified copy of Priority Document(s)
(if foreign priority is claimed)

14. ☐ Other:

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☐ Continuation ☒ Divisional ☐ Continuation-in-part (CIP) of prior application No. 09/057,630

18. CORRESPONDENCE ADDRESS

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label here)

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Table 1. Demographic characteristics of the study population	
Age (years)	50.0 ± 10.0
Gender	
Male	50.0%
Female	50.0%
Education (years)	12.0 ± 2.0
Occupation	
Professional	20.0%
Managerial	10.0%
Technical	10.0%
Skilled	10.0%
Unskilled	40.0%
Marital status	
Married	80.0%
Single	10.0%
Divorced	5.0%
Widowed	5.0%
Health status	
Good	80.0%
Fair	10.0%
Poor	10.0%
Smoking status	
Smoker	20.0%
Non-smoker	80.0%
Alcohol consumption	
Regular	10.0%
Occasional	10.0%
Never	80.0%
Family size	3.0 ± 1.0
Income (USD/month)	1000.0 ± 500.0
Health insurance	
Yes	80.0%
No	20.0%

In re Application of:	:	
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Michael A. Gaynes et al.	:	
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Serial No.: To be assigned	:	Art Unit: To be assigned
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Filed: Herewith	:	Examiner: To be assigned
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For: BONDING TOGETHER	:	Atty Docket: EN997170C
SURFACES	:	
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PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to initial examination, please amend the above-captioned case as follows.

IN THE SPECIFICATION

Please amend the specification as follows.

Page 1, following the title, insert

---Cross-Reference to Related Application

This application is a divisional of copending U.S. Patent Application S.N. 09/057,630 filed April 9, 1998.---

IN THE CLAIMS

Please cancel claims 1-27 without prejudice to their reentry at some later date.

REMARKS

None of these amendments is believed to involve any new matter. Accordingly, it is respectfully requested that the foregoing amendments be entered, that the application as so amended receive an examination on the merits, and that the claims as now presented receive an early allowance.

Respectfully submitted,

Burton A. Amernick Reg. No. 25,787, for

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Date: *June 15, 2006*

BONDING TOGETHER SURFACES

DESCRIPTION

Technical Field

5 The present invention is concerned with a method for adhesively bonding two surfaces together with a liquid adhesive and particularly is concerned with significantly reducing, if not entirely eliminating, air entrapment in the bond. In addition, the present invention is directed to an assembly for bonding two surfaces together as well as
10 directed to the bonded surfaces obtained according to the present invention. The present invention is especially applicable for binding flat or at least substantially planar surfaces such as used for fabricating microelectronic components such as liquid crystal display assemblies and
15 heat-sink attachments as well as various commercial applications such as windowpane glass and auto windshield applications.

Background of Invention

20 A variety of industrial and commercial applications require bonding surfaces together and, in certain instances, flat surfaces having relatively large areas. Included in these applications are microelectronics applications for bonding liquid crystal display assemblies and especially relatively large liquid crystal display assemblies and heat-sink attachments, and such commercial applications as
25 windowpane glass and auto windshield applications. When laminating or bonding flat surfaces with a liquid adhesive, the ever present problem of air entrapment requires special

attention. For instance, even though a surface may appear flat or planar, small topographic variations allow contacting at multiple points during mating. As the adhesive spreads from such multiple points, the advancing fronts can meet and thereby trap pockets of air.

The larger the area of the mating surface, the higher the incidence of air entrapment. Furthermore, the lower the viscosity of the adhesive, the higher the incidence of air entrapment.

Trapped air, depending upon the desired product, presents problems of varying degrees. For instance, when dealing with bonding large liquid crystal display assemblies, the individual LCD tiles are arranged in a matrix and secured to a tile carrier. The tile carrier typically includes a cover plate and a back plate with the LCD tiles sandwiched between them. The bonding of the back plate and cover plate to the liquid crystal display tiles should be as void free as possible. In order to achieve a void free bond, proper dispensing of the adhesive mass along with providing a pattern that allows spreading out from the center outward and sweeping air out as the front advances must be achieved. In addition, the surfaces to be bonded must be mated parallel to each other. It is also desirable that the point contact of the mating surfaces with the adhesive between them be controlled and that the pattern employed permit complete coverage of the surface area of the mating substrates regardless of shape such as rectangular, square or polygon. Also, it is necessary to control the bond line.

With respect to these requirements, the proper dispensing of the adhesive mass can be readily achieved employing metered dispense units well known in the art. Moreover, it has previously been determined that an X pattern extending the entire diagonal length of the surfaces to be bonded is necessary for achieving complete coverage. Furthermore, a majority of the adhesive should be dispensed in the center of the adhesive pattern since spreading is initiated in the center, and spreads out radially. Nevertheless, it has been found that regardless of the pattern geometry in the center, e.g. circular, elliptical, square, smaller scale X pattern and the like, the geometry of the spreading area quickly reverts to circular or elliptical. However, even when employing an X pattern with the diagonal spokes extending all the way to the corners of the surface to be bonded, a void free bond line is not necessarily achieved.

Summary of Invention

The present invention is concerned with substantially eliminating, if not entirely eliminating, voids when bonding surfaces together and especially flat surfaces. In particular, the present invention is concerned with a method for bonding two flat planar surfaces together. The method of the present invention comprises providing on a major surface of one of the surfaces to be bonded a central single point adhesive contact deposit within the vicinity of the center of the surface. Also provided on a major surface of one of the surfaces is adhesive arranged and extending from a central portion deposit in a spoke-like array diagonally across substantially the entire surface. The two surfaces are mated parallel to each other with the adhesive located

between the two surfaces and pressed together to thereby cause the adhesive to spread and cover the surfaces and thereby bond the surfaces together.

5 The present invention is also concerned with an assembly for bonding two surfaces together which comprises central single point adhesive contact deposit present within the vicinity of the center of one of the surfaces. Also provided on a major surface of one of the surfaces is adhesive arranged and extending from a central portion deposit in a spoke-like array diagonally across substantially the entire surface.

10 Furthermore, the present invention is concerned with an article that comprises two surfaces bonded together wherein one of the surfaces has a smaller surface area than that of the other of the surfaces. The surfaces are bonded together by an adhesive located between the surfaces and covering the entire area of the smaller surface area and being void free and exhibiting a wavelike undulating fillet profile on the outer perimeter of the smaller surface.

15 Still other objects and advantages of the present invention will become readily apparent by those skilled in the art from the following detailed description, wherein it is shown and described only the preferred embodiments of the invention, simply by way of illustration of the best mode contemplated of carrying out the invention. As will be realized the invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, without departing from the invention. Accordingly, the description is to be regarded as illustrative in nature and not as restrictive.

Summary of Drawing

The figure illustrates two surfaces to be bonded in unassembled form according to one embodiment of the present invention.

Best and Various Modes for Carrying Out Invention

Reference to the figure will be made to help facilitate an understanding of the present invention.

The present invention is concerned with bonding together two surfaces and to achieve a void free bond between the two surfaces. The surfaces 1 and 2 bonded together according to the present invention preferably exhibit flat or planar profile and include various glass substrates, ceramic substrates and metal surfaces. A particular example is the cover and back glass plate used for fabricating liquid crystal display assemblies including relatively large liquid crystal display assemblies including those having dimensions of at least 9" x 12". It is understood that a "flat" or "planar" surface as used in describing the present invention refers to surfaces that can include small topographic variations such as those inevitably present from various manufacturing methods.

It has been found, according to the present invention, that in order to achieve a void free bond, a central, single point adhesive contact 3 must be provided. According to the present invention, this single point contact 3 can be achieved by depositing a dot-like substantially hemispherical shaped adhesive deposit within the vicinity of the center of one of the surfaces to be bonded. In the case

of the adhesive having a viscosity of less than about 30,000 centipoise, cps, it is preferred that the deposit be placed on that substrate used as the top substrate when bringing together the two surfaces during the bonding procedure. In this case, after being applied to surface 1, the deposit 3 due to its flow characteristics may take on a form generally resembling a Hershey Kiss®. In that manner, the downward forces tend to facilitate forming such a shaped adhesive deposit. Using an adhesive having a viscosity less than about 30,000 centipoise on the surface to be used as the bottom surface when the two surfaces are brought together will tend to cause it to self-level and not be able to maintain the necessary single point contact. On the other hand, when the adhesive employed has a viscosity of greater than 30,000 centipoise, the dot-like generally hemispherical shaped adhesive deposit 3 can be placed on the flat surface of the substrate that will be placed as the bottom or top substrate when the two surfaces are brought together during the bonding process. When located on the bottom substrate, the height of the single point contact deposit 3 will need to be greater than that of the remainder of the adhesive array 4.

The central single point adhesive contact typically has a diameter of about 30 mils to about 1/4" and more typically about 60 to about 100 mils. The height is typically about 1/2 of the diameter and usually ranges from about 15 mils to about 1/8".

It is also necessary, according to the present invention, that on a major surface of one of the surfaces there is provided an adhesive 4 that extends outward from a central point deposit 5 in a spoke-like array diagonally

across substantially the entire surface. The diameter of the central point deposit 5 is at least as great as the diameter of the single point adhesive contact in order to receive or contact the single point adhesive contact during the bonding process. The deposit 5 is typically about 5% to about 50% and more typically about 5 to about 15% of the surface 2 to be bonded. According to preferred aspects, the spoke-like array resembles an X pattern across the surface. According to preferred aspects of the present invention, at least four diagonal spokes emanating from the center are provided. Also, if desired, additional adhesive deposits can likewise be provided, typically up to about an additional four spoke-like deposits. It is desired that the individual spokes be substantially equidistant from adjacent deposits and generally have a height or thickness of about 2 to about 50 mils. Every spoke-like deposit in the array should have substantially the same height.

The adhesives employed are preferably thermosetting adhesives and most preferably curable with actinic light such as UV light. The adhesive composition for the central single point adhesive contact can be the same adhesive as employed for the spoke-like pattern but does not necessarily need to be the same exact composition. However, the two adhesives need to be compatible with each other. Typical adhesives are acrylic adhesives, silicones and urethane acrylates and preferably have viscosity of about 1000 cps or less. One such commercially available urethane acrylate adhesive is Luxtrak 4031 from Abelstik Labs. Other suitable adhesives include Luxtrak 4170 from Abelstik Labs, a urethane acrylate, Luxtrak 4116 from Abelstik Labs, a urethane acrylate, VLC701 from Glotrax, Inc., a urethane

acrylate and X3-6211 from Dow Corning, a polydimethylsiloxane.

5 The adhesive array, having a viscosity of 1000 cps, is typically dispensed on a surface of the substrate that is to be used as the bottom substrate during the bonding process.

10 The surfaces 1 and 2 to be bonded are then placed on top of each other and are mated parallel to each other with the adhesive between the surfaces and slowly brought together. The mating process, for example with 9" x 12" glass substrates, typically takes about 1 to about 4 minutes. As the surfaces are mated to each other, the adhesive beginning from the center begins to flow out radially until it reaches the edge of the surfaces being the same size, once the adhesive reaches the edge and goes beyond it may be desirable to remove any excess adhesive around the edges. On the other hand, when one of the surfaces is of a smaller size than the other, the material once it reaches the edge exhibits a wavy fillet front on the outer perimeter of the small surface. In the case of different size surfaces, the adhesive pattern is provided so that it only covers the smaller of the surfaces.

15 The following non-limiting example is illustrated to further illustrate the present invention.

Example

25 In this example a backplate 9½" x 12½" is adhesively bonded to a 9" x 12" liquid crystal display (LCD) with a 2 mil thick clear adhesive.

5 A UV light curing adhesive from Ablestik Labs (Luxtrak
4031), having a viscosity of 1000 cps, is dispensed on the
backplate (the bottom surface) in an X pattern with
additional adhesive dispensed in the center, as shown in the
figure. The majority of the adhesive dispensed in the
center starts to spread and self-level due to its low
viscosity. The thickness of the adhesive on the backplate
is approximately 40-50 mils in the center and approximately
30-40 mils in the spokes of the X pattern. A hemispherical
10 dot (mass) of the same adhesive is dispensed at or near the
center of the LCD (the top surface) as shown in the figure.
This adhesive dot, also referred to as the seed dot, is
approximately 100 mils in diameter, and 50 mils in height.
These two surfaces to be bonded are now aligned (optically)
15 and moved close to each other vertically. As the two
surfaces come close, the adhesive between the two surfaces
makes a point contact in the center, and spreads out
radially, sweeping the air out between the surfaces. The
speed of vertical travel of the surfaces is slow enough to
20 provide enough time for the adhesive to flow and cover the
entire surfaces. Once the desired adhesive thickness is
achieved, the bonded parts are exposed to a UV light which
cures the adhesive between the two surfaces, bonding them
together.

25 The foregoing description of the invention illustrates
and describes the present invention. Additionally, the
disclosure shows and describes only the preferred
embodiments of the invention but, as mentioned above, it is
to be understood that the invention is capable of use in
30 various other combinations, modifications, and environments
and is capable of changes or modifications within the scope

of the inventive concept as expressed herein, commensurate with the above teachings and/or the skill or knowledge of the relevant art. The embodiments described hereinabove are further intended to explain best modes known of practicing the invention and to enable others skilled in the art to utilize the invention in such, or other, embodiments and with the various modifications required by the particular applications or uses of the invention. Accordingly, the description is not intended to limit the invention to the form disclosed herein. Also, it is intended that the appended claims be construed to include alternative embodiments.

CLAIMS

What is claimed is:

1 1. A method for adhesively bonding two surfaces
2 together which comprises providing on one of said surfaces a
3 central single point adhesive contact deposit;

4 providing on one of said surfaces adhesive extending
5 outward from a central portion deposit in a spoke-like array
6 diagonally across substantially the entire surface;

7 bringing together said two surfaces, one on top of the
8 other, with the adhesive located between said surfaces to
9 cause said adhesive to spread out and cover said surfaces to
10 thereby bond them together.

1 2. The method of claim 1 wherein said central, single
2 point adhesive contact deposit is a dot-like generally
3 hemispherically shaped adhesive deposit.

4 3. The method of claim 1 wherein said adhesive has a
5 viscosity of greater than 30,000 centipoise.

6 4. The method of claim 1 wherein said adhesive has a
7 viscosity of less than 30,000 centipoise and the central
8 single point adhesive contact deposit is located on the
9 surface that is located as the upper surface during the
10 bonding; and said central portion deposit has a diameter at
least as large as the diameter of said single point adhesive
contact deposit for contacting with said single point
adhesive contact deposit during bonding.

1 5. The method of claim 1 wherein said surfaces are
2 flat.

1 6. The method of claim 5 wherein said flat surfaces
2 are glass.

1 7. The method of claim 5 wherein said flat surfaces
2 are glass panels for fabricating large liquid crystal
3 display assemblies.

1 8. The method of claim 1 wherein one of the surfaces
2 has a smaller area than the other of the surfaces.

1 9. The method of claim 1 wherein the adhesive is a
2 thermosetting adhesive.

1 10. The method of claim 1 wherein said spoke-like
2 array comprises at least four spoke-like adhesive deposits.

1 11. The method of claim 1 wherein said spoke-like
2 array comprises up to eight spoke-like adhesive deposits.

1 12. The method of claim 1 wherein each of said spoke-
2 like deposits is about 2 to about 50 mils thick.

1 13. The method of claim 2 wherein said deposit has a
2 diameter of about 30 mils to about 1/4" and a height of
3 about 15 mils to about 1/8".

1 14. The method of claim 13 wherein said dot-like
2 generally hemispherical shaped adhesive deposit has a
3 diameter of about 60 to about 100 mils and a height of about
4 30 to about 50 mils.

1 15. The method of claim 13 wherein the height of the
2 spoke-like deposits is about 2 to about 50 mils.

1 16. An assembly for bonding two surfaces together
2 which comprises a central, single point adhesive contact
3 located on one of said surfaces; and adhesive extending from
4 a central point deposit in a spoke-like array diagonally
5 across substantially the entire surface of one of said
6 surfaces.

1 17. The assembly of claim 16 wherein said spoke-like
2 array comprises at least four spoke-like adhesive deposits.

1 18. The assembly of claim 16 wherein said spoke-like
2 array comprises up to eight spoke-like adhesive deposits.

1 19. The assembly of claim 16 wherein each of said
2 spoke-like deposits are about 2 to about 50 mils thick.

1 20. The assembly of claim 16 wherein said central,
2 single point adhesive contact deposit is a dot-like
3 generally hemispherical shaped adhesive deposit.

1 21. The assembly of claim 20 wherein said deposit has
2 a diameter of about 30 mils to about 1/4" and a height of
3 about 15 mils to about 1/8".

1 22. The assembly of claim 21 wherein said dot-like
2 generally hemispherical shaped adhesive deposit has a
3 diameter of about 60 to about 100 mils and a height of about
4 30 to about 50 mils.

1 23. The assembly of claim 21 wherein the height of the
2 spoke-like deposits is about 2 to about 50 mils.

1 24. The assembly of claim 16 wherein said adhesive has
2 a viscosity of less than 30,000 centipoise.

1 25. The assembly of claim 16 wherein said adhesive is
2 a thermosetting adhesive.

1 26. The assembly of claim 16 wherein said surfaces are
2 flat.

1 27. The assembly of claim 16 wherein said central
2 single point adhesive contact is located on one of the
3 surfaces and the spoke-like array on the other surface.

1 28. An article comprising two surfaces bonded together
2 wherein one of said surfaces has a smaller surface area than
3 that of the other of said surfaces; said surfaces are bonded
4 together by an adhesive located between said surfaces over
5 the entire area of the smaller area surface; said adhesive
6 being void-free and exhibiting a wavelike undulating profile
7 at the edges of the smaller surface.

1 29. The article of claim 28 wherein said adhesive is a
2 thermosetting adhesive.

1 30. The article of claim 28 wherein said surfaces are
2 flat.

BONDING TOGETHER SURFACES

ABSTRACT OF DISCLOSURE

Two surfaces are adhesively bonded together by providing on one of the surfaces a central, single point adhesive contact deposit and providing on one of the surfaces, adhesive extending from a central point deposit in a spoke-like array diagonally across substantially the entire surface. Also provided is the article obtained by the above method as well as the assembly used for bonding the two surfaces together. The surfaces are brought together, one on top of the other, with the adhesive located between the surfaces to cause the adhesive to spread out and cover the surfaces to thereby bond them together.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: :
: Michael A. Gaynes et al. :
Serial No.: : Art Unit:
Filed: Herewith : Examiner:
For: BONDING TOGETHER : Atty Docket: EN997170C
SURFACES :
:
:
:

SUBMISSION OF FORMAL DRAWINGS

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Applicants submit herewith 1 sheet of formal drawings.

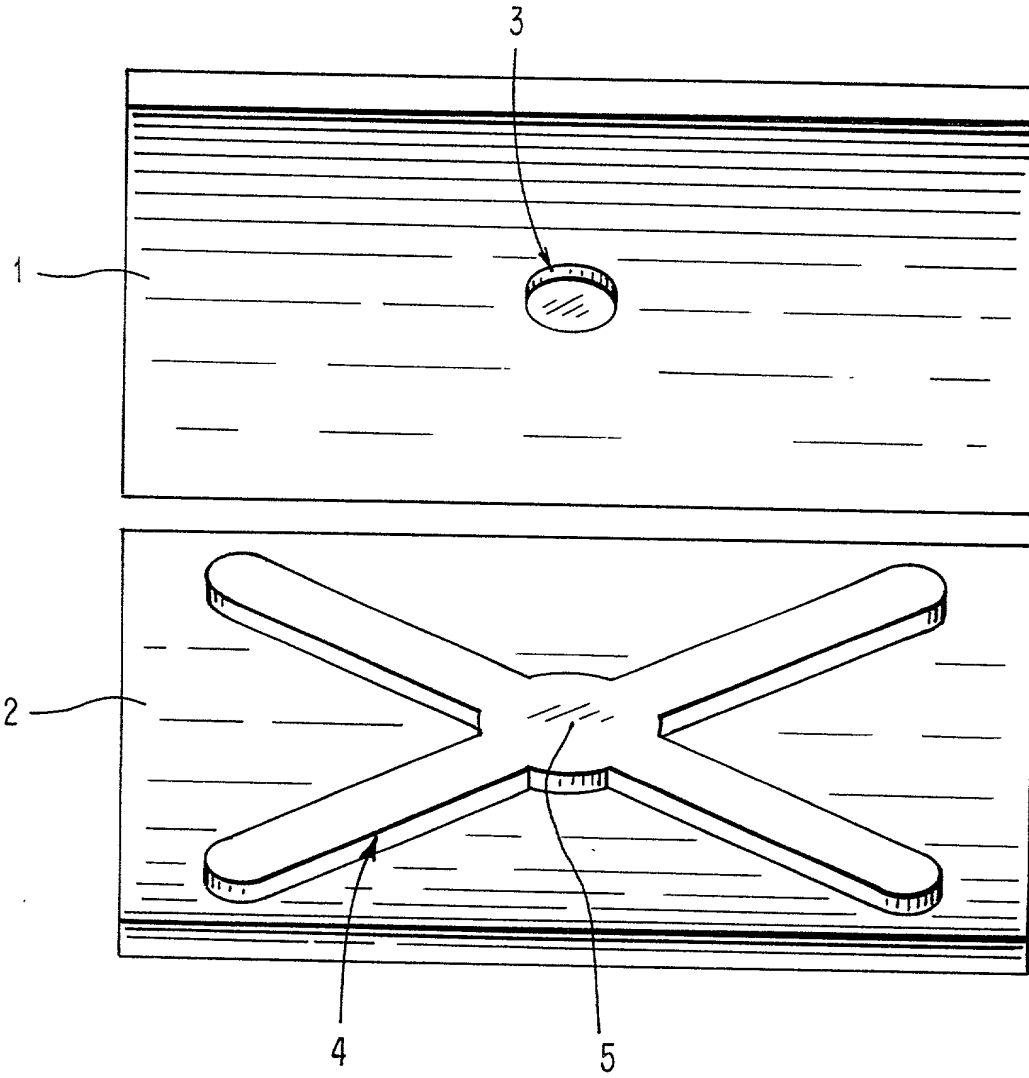
Respectfully submitted,



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Date: June 13, 2000

005790" 917E6360



00593446 061500

DECLARATION FOR PATENT APPLICATION

EN997170

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **Bonding Together Surfaces** the specification of which: (check one)

☒ is attached hereto. ☐ was filed on , as United States Patent Application Serial No. or PCT International Application Number , and was amended on (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with 37 CFR § 1.56(a).

Prior Foreign Application(s): I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate listed below, or § 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Priority Claimed

☐ ☐

Yes No

☐ ☐ ☐

Yes No

(Application No.)

(Country)

(Day/Month/Year Filed)

(Application No.)

(Country)

(Day/Month/Year Filed)

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below:

Application No.

Filing Date

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by 35 U.S.C. § 112, first paragraph, I acknowledge the duty to disclose material information as defined in 37 CFR § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application

(U.S. Application Serial No.)

(U.S. Filing Date)

(Status--patented, pending, abandoned)

(U.S. Application Serial No.)

(U.S. Filing Date)

(Status--patented, pending, abandoned)

I hereby appoint the following attorneys and/or agents to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: David L. Adour, Reg. No. 29,604, Lawrence R. Fraley, Reg. No. 26,885, Arthur J. Samodovitz, Reg. No. 31,297, Bernard Tiegerman, Reg. No. 29,707; John R. Pivnichny, Provisional Reg. No. P-43,001; all of INTERNATIONAL BUSINESS MACHINES CORPORATION; Elliott I. Pollock, Reg. No. 16,906, George Vande Sande, Reg. No. 17,276, Robert R. Priddy, Reg. No. 20,169, Burton A. Amernick, Reg. No. 24,852, Stanley B. Green, Reg. No. 24,351, Richard Wiener, Reg. No. 18,741, Townsend M. Belser, Jr., Reg. No. 22,956; Morris Liss, Reg. No. 24,510, Martin Abramson, Reg. No. 25,787, George R. Pettit, Reg. No. 27,369, Louis Woo, Reg. No. 31,730, Elzbieta Chlopecka, Reg. No. 32,767, Eric J. Franklin, Reg. No. 37,134 and Robert Scott Wales, Reg. No. 39,413, all of POLLOCK, VANDE SANDE & PRIDDY; John E. Hoel, Reg. No. 26,279, Christopher A. Hughes, Reg. No. 26,914, Edward A. Pennington, Reg. No. 32,588, Joseph C. Redmond, Jr., Reg. No. 18,753, all of MORGAN & FINNEGAN, L.L.P.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon

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Inventor's Signature: Michael A. Gaynes

Date: 4/9/98

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DECLARATION FOR PATENT APPLICATION

Page Two

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Inventor's Signature *Ramesh R. Kodnani* Date 4/9/98

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Citizenship India

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Full name of third joint inventor (if any): _____

Inventor's Signature _____ Date _____

Residence Address _____

Citizenship _____

Post Office Address _____

Full name of fourth joint inventor (if any): _____

Inventor's Signature _____ Date _____

Residence Address _____

Citizenship _____

Post Office Address _____

Full name of fifth joint inventor (if any): _____

Inventor's Signature _____ Date _____

Residence Address _____

Citizenship _____

Post Office Address _____

Full name of sixth joint inventor (if any): _____

Inventor's Signature _____ Date _____

Residence Address _____

Citizenship _____

Post Office Address _____

Full name of seventh joint inventor (if any): _____

Inventor's Signature _____ Date _____

Residence Address _____

Citizenship _____

Post Office Address _____

Full name of eighth joint inventor (if any): _____

Inventor's Signature _____ Date _____

Residence Address _____

Citizenship _____

Post Office Address _____